Predicting Mass Evacuation in the Wake of Natural or Human-caused Disasters

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Suppose terrorists were to detonate radiological dispersion devices (RDDs), or "dirty bombs," in Portland, Phoenix, and the U.S. Territory of Guam, causing widespread contamination. This was the scenario for *Top Officials 4*—the nation's premier terrorism preparedness exercise—which took place in October 2007. To respond effectively, officials at the federal, state, territorial, and local level quickly needed information on numbers of casualties and affected individuals. This exercise and recent natural disasters show the need to develop contingency plans for emergency evacuation. In particular, rural communities and metro areas must be ready to absorb a large influx of evacuees, leading to increased demands on infrastructure and resources. It is, for example, estimated that one million people were evacuated due to Hurricane Katrina in 2005 (Fig. 1), of which at least 150,000 took refuge in Houston. Similarly, about half a million residents left their homes to seek shelter as the California wildfires raged earlier this year. To assist the Department of Homeland Security in its contingency planning effort, Leticia Cuéllar, Anders Hansson, and Nick Hengartner of CCS-3, together with Deborah Kubicek of D-6, have developed a fast-response tool to predict mass evacuation. The tool can guide pre-event resource allocation and aid emergency management teams and first responders to make timely and informed evacuation decisions.

Given a particular scenario/event, the tool generates a synthetic population of households for the area at risk. This is done in such a way that certain demographical characteristics (such as income, number of children, race) of the synthetic households are statistically equivalent to census data. We subsequently estimate the probability that each household will evacuate based on its demographics (e.g., number of children and elderly in the household, single-unit dwelling, mobile home) and risk data (actual and perceived risk, where the latter depends on previous experience). Similarly, risk and demographical data (income, education, sex, and race) influence the household's choice of shelter type: family/friends, hotel/motel, or public shelter. The tool finally makes use of a gravity model in which the attractiveness of a shelter increases with the number of additional evacuees it can harbor, but declines with increasing remoteness, in order to geo-locate the preferred shelter type.

The output of the tool informs the decision maker about a) the influx of evacuees to neighboring communities (expressed in number of people, broken down by shelter type preference, in Figs.1,2), and b) the number of people that neglect to evacuate in each impacted census block group. These results are readily analyzed and visualized using a geographic information system. The output can also be shared with other analysis tools employed by LANL's National Infrastructure Simulation and Analysis Center (NISAC) to assess the impact on critical infrastructure and key resources.

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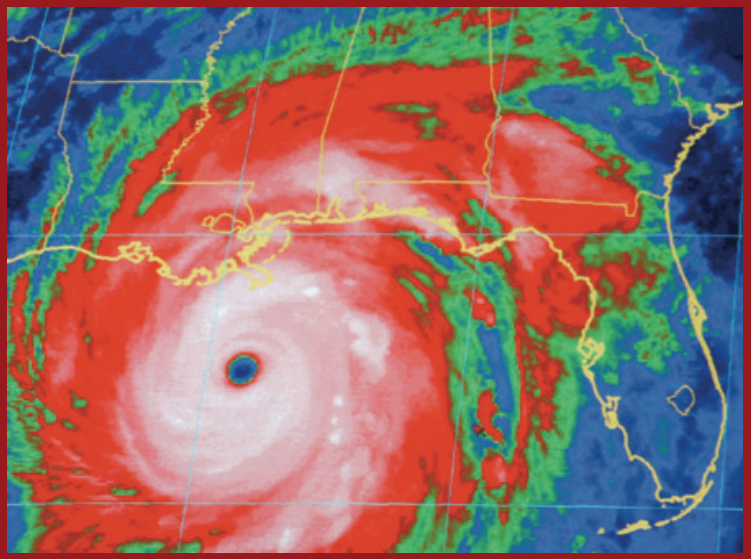

Fig. 1. Hurricane Katrina near peak strength on August 28, 2005.

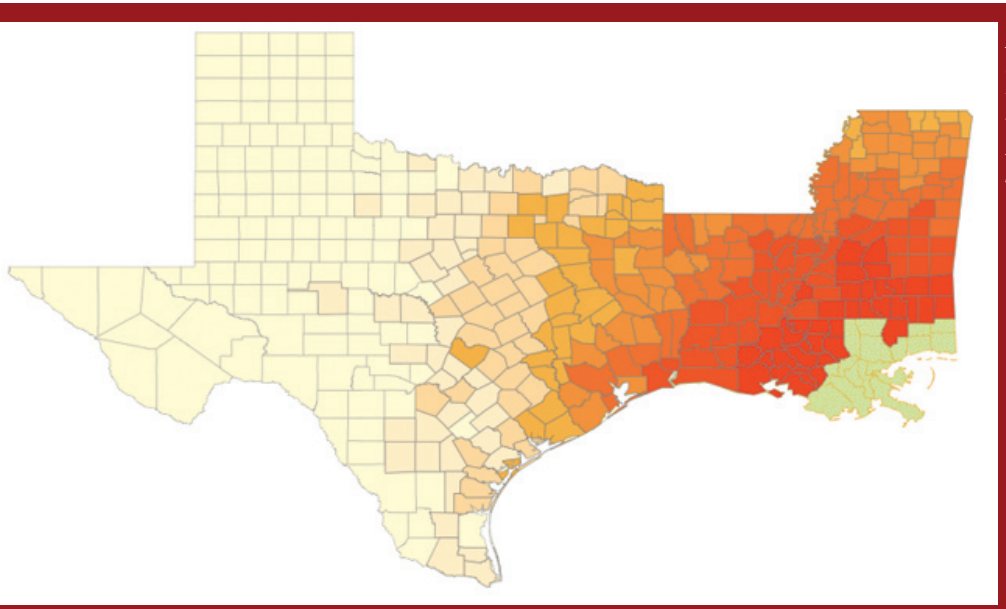

Fig. 2. Predicted influx of evacuees to neighboring family/friends in the wake of Hurricane Katrina. Darker red indicates a higher influx.

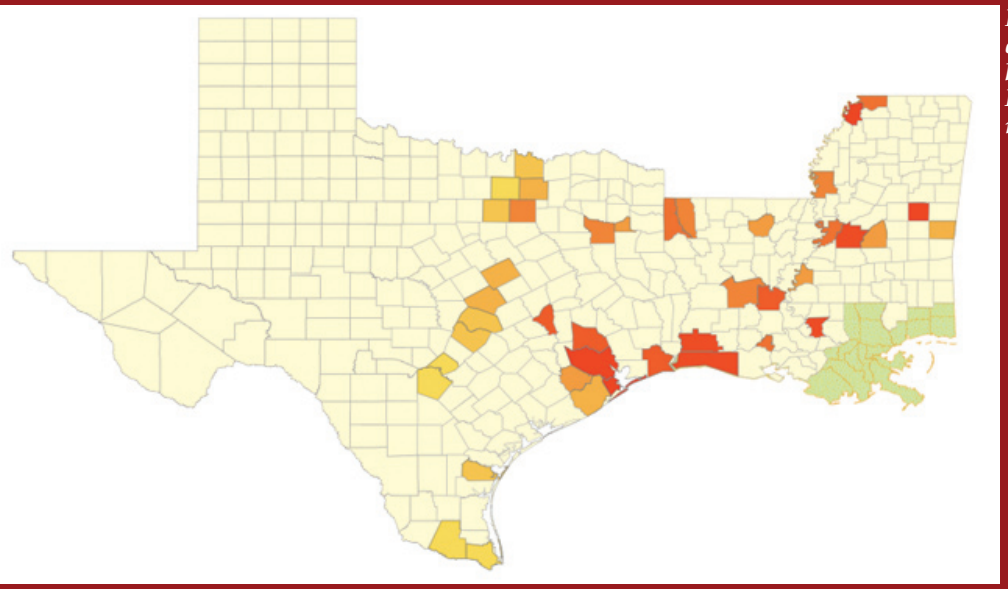

Fig. 3. Predicted influx of evacuees to neighboring hotels/motels in the wake of Hurricane Katrina. Darker red indicates a higher influx.